**National Aeronautics and
Space Administration**

**Software Independent Verification & Validation Facility
Fairmont, WV 26554**

Office of Safety and Mission Assurance (OSMA) Software Assurance Research Program

Operating Plan (FY04)

26 August 2003

OSMA

Office of Safety and Mission Assurance

SARP

Software Assurance Research Program

Operating Plan (FY04)

Submitted By:

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1.0   INTRODUCTION

Code Q, the NASA Office of Safety and Mission Assurance (OSMA) has established the Software Assurance Research Program (SARP) to advance and improve the assurance of mission critical software throughout NASA. Code Q funds and oversees the program. The NASA Independent Verification and Validation (IV&V) Facility manages the program for Code Q. NASA centers and their contractors, the IV&V Facility, West Virginia University (WVU), as well as other contractors, and universities conduct software assurance research under the SARP.

The goal of this research program is to provide NASA with the software assurance practices, methods, and tools needed to produce safe and reliable software. This program is designed to address fundamental software assurance problems in the field of software engineering primarily as it relates to software safety, quality, independent verification and validation (IV&V), testability, and reliability. It is intended to develop and transfer to NASA projects, software assurance practices, methods and tools to improve the quality of the software produced by and for NASA, and to assist NASA in becoming a leader in the development of safe and reliable, cost effective software. Thus, by addressing forward thinking research as well as addressing current needs, the OSMA SARP helps assure that sufficient and appropriate software risk mitigation is applied to the software which controls and monitors our systems.

This document is an operating plan that the Centers and their contractors, WVU, and the IV&V Facility will follow to achieve the goal of the NASA SARP.

The OSMA Deputy Associate Administrator oversees the SARP. He establishes research objectives, appro ves the results of the Source Evaluation Board (SEB), and delegates the administrative management of the SARP to the IV&V Facility.

1.1. Purpose of This Document

The purpose of this document is to provide the NASA OSMA with a comprehensive SARP Operating Plan for FY04. The Deputy Associate Administrator's signing of this plan constitutes final acceptance of the proposals listed within as recommended for selection for award. The IV&V Facility will send selection letters to contractors and universities. Funding will be received after the budget passes. Centers will receive the money directly. The IV&V Facility will issue grants and contacts through the Goddard Space Flight Center procurement office as appropriate.

1.2. Reference Documents

Table 1-1: Reference Documents

Document Number	Document Title
N/A	The OSMA Software Assurance Program Research Program (SARP) Level I Technical Program Plan (FY04-FY06) February 15, 2002
SARP-NRA-0301	NASA Research Announcement So ftware Assurance Research
N/A	Software Assurance Research Initiative Proposal Evaluation Plan
IVV 09-3	Research Program

1.2.1. OSMA SARP Level I Technical Program Plan

The Level I Technical Program Plan provides a program overview; participant authority, roles and responsibilities; proposal handling procedures; and resource projections.

The program overview includes program purpose, background, goal and objectives, implementation strategy, proposal evaluation criteria, proposal categories and program authority designation.

Authority, roles and responsibilities are described for
– The Deputy Administrator for OSMA
– Goddard Space Flight Center
– The OSMA SARP proposal Source Evaluation Board
– NASA's strategic enterprises
– OSMA
– The IV&V Facility
– The NASA Software Working Group (SWG)
– NASA centers
– Universities and industry
– Principal investigators (NASA, university and industry)

1.2.2. International Organization for Standardization (ISO) Procedures and Work Instructions

IVV 09-3 is the IV&V Facility's ISO 9001 standard system level procedure for defining and managing the research program. Within the system level procedure IVV 09-3 addresses

standard operating procedures for evaluating research initiatives, selecting new initiatives, processing procurements, processing research deliverables, conducting research initiative performance reviews, and publishing research results.

This operating plan conforms to these procedures.

2.0   OSMA FY04 SARP IMPLEMENTATION PLAN

The OSMA FY04 SARP implementation strategy is to conduct:

a) Applied software assurance research through NASA Center Initiatives (CI) that are accomplished through university grants and industry contracts, or in-house civil servant work.

b) Theoretical and applied software assurance research through West Virginia University Initiatives,

c) Technical analyses of initiative deliverables with support from IV&V Facility contractors to ensure that quality research is being done.

2.1. Annual Cycle

The OSMA SARP follows an annual cycle of key activities. Table 2-1 lists the key activities and corresponding dates for FY04.

Table 2-1: OSMA SARP Key Activities and Dates

Activity	Date
Release Level I plan	22 April 2003
Issue NRA	20 May 2003
Receive proposals	June 29, 2003
Select for award	1 August 2003
Release Level II plan	15 August 2003
Award contracts	1 January 2004

2.2. Renewed Initiatives

For FY04, Code Q agreed to allow successful research initiatives to continue for up to 3 years without being required to submit a new proposal to receive incremental funding. Formerly, to get funding, all program participants were required to submit a proposal every

year regardless of whether they had an existing contract or grant whose period of performance hadn't expired.

During FY03, the IV&V Facility conducted quarterly reviews to determine the progress of each SARP research initiative. For those on-going initiatives which had proposed continuing work into FY04, the IV&V Facility evaluated the quarterly review results and recommended that all should be continued. (Note that a number of initiatives had planned on continuing, but their original proposals didn't include detailed cost or schedule information needed to continue their work into FY04. These were told to submit new proposals.) The SEB reviewed and concurred with the IV&V Facility's recommendations. Funding recommendations are summarized in Section 4.0 REQUEST FOR FUNDING, Table 4-2 Renewed Initiative FY04 Incremental Funding Recommendations.

2.3. New Initiatives

Following is a summary of the results of the FY04 proposal solicitation, evaluation and selection process and the approach that the IV&V Facility will employee to manage the FY04 research initiatives.

2.3.1. Solicitation

The OSMA SARP used the Level I Technical Program Plan to solicit participation by NASA Center personnel and their contractors. The Level I Plan was released as part the NASA-wide Program Operating Plan (POP) call. To solicit proposals from universities and industrial organizations, the OSMA SARP used a NASA Research Announcement (NRA). For WVU proposals, the NASA IV&V Facility Research Lead identifies current research needs to the WVU Research Chair and the WVU Research Chair provides WVU research proposals to the NASA IV&V Facility Research Lead.

The Level I Technical Program Plan and the NRA contained identical statements of program background, goal, objectives, implementation strategy, evaluation criteria and proposal categories. Stated resource projections were different. The Level I plan stated that approximately $4.6 M was projected for the total OSMA SARP program while the NRA stated that an order of magnitude estimate of the funds to be available for NRA awards was $350 K.

In February 2003, the IV&V Facility submitted a Level 1 Technical Program Plan to Code Q/OSMA. Code Q provided an Operating Plan that included the IV&V Facility Level 1 Technical Program plan to Code B. Code B incorporated the Code Q Operating Plan into the Program Operating Plan (POP) call. Code B issued the POP call to the Centers inviting them to submit proposals for FY04 funding.

On 20 May 2003, GSFC procurement issued a synopsis of the NASA Research Announcement for Software Assurance Research (NRA SARP 0301). The NRA was also posted on the web site: http://www.ivv.nasa.gov/business/research/index.shtml .

The web site, http://www.ivv.nasa.gov/business/research/index.shtml was established to provide guidance to submitters. The web site included

- Links to the FY04-06 Level I Technical Program Plan and NRA SARP 0301;
- the FY03-05 Level I plan;
- the FY03 Level II Plan,
- a template for Center software initiative proposal format,
- Suggested proposal research topics,
- Frequently asked questions and answers
- Link to the Software Assurance Symposium website that includes technical presentations of past Symposia.

2.3.2. Evaluation

In response to the POP call and the NRA, eighty-eight proposals were submitted and reviewed. Requests for FY04 funding totaled $13,884,794. Formerly, to get funding, all program participants were required to submit a proposal every year regardless of whether they had an existing contract or grant whose period of performance hadn't expired.

On average, each proposal received 5 evaluations. A total of 454 evaluations were completed.

Proposals were evaluated in two stages, first, by the Software Working Group (SWG) and the Source Evaluation Board (SEB) using a web-based evaluation tool, and then by the SEB in a group discussion. The SEB provided selection recommendations to the Source Selection Official (SSO).

2.3.2.1. Software Working Group Evaluators

The SWG provided evaluations of the proposals. The SWG members or their designees completed the evaluations in the OSMA SARP Center Initiative Management (CIM) Tool. In the CIM Tool, they opened each proposal and a corresponding evaluation form. Upon reviewing the proposal and completing and submitting the evaluation form, the CIM Tool produced a real-time report of the results of all the evaluations of all the proposals that was accessible to the SEB.

Each of the ten NASA Centers has representation on the SWG. The Centers' SWG members or their designees performed the Center evaluations.   To ensure that all proposals received at least 2 evaluations, the IV&V Facility Research Lead, through the IV&V support contractor, requested each SWG members to evaluate 18 specific proposals. He assigned a different set of 18 to each SWG member. For the larger Centers, he also requested them to evaluate at least 12 others of their choice. For the smaller Centers, Stennis and Dryden, he requested them to evaluate at least 5 others of their choice.

2.3.2.2. Source Evaluation Board

The SEB members individually evaluated the proposals at the same time the SWG evaluated them. After the SWG completed their evaluations and the SEB members completed their individual evaluations, the SEB reviewed the evaluation scores and comments and met as a board to complete the evaluation and selection recommendations. The SEB used the SWG's evaluations and comments extensively and made their recommendations based on the SWG evaluations and comments as well as program policy factors. The SEB's recommendations for funding new initiatives are summarized in Section 4.0 REQUEST FOR FUNDING, Table 4-3: FY04 New Proposals Recommended for Funding.

2.3.2.3. Evaluation Criteria

Ten evaluation criteria were applied. The evaluation criteria are:

1. Relevance to software safety and mission assurance
2. Clarity of objectives
3. Feasibility of methods and procedures
4. Potential for technology transfer to NASA software projects
5. Clarity of success criteria and progress metrics
6. Value of the proposed research for the estimated cost
7. Uniqueness of proposed research
8. Qualifications of the research team to do the proposed research
9. Past performance of the research team (where available)
10. Overall quality of proposed initiative

2.3.2.4. Evaluation Criteria Weighting Factors

Relevance to software safety and mission assurance (criterion 1), potential for technology transfer to NASA software projects (criterion 4), and the overall quality of the proposed initiative (criterion 10) were each weighted twice as much as the other criteria.

2.3.2.5. Automated Tool Support

The IV&V Facility support contractor provided an automated tool that functioned as the repository for proposal evaluations. The contractor also provided automated tools that, for each proposal

- Compiled evaluator scores for each criterion

- Computed grand average score

- Computed weighted grand average score

- Computed standard deviation of weighted total scores.

For all proposals, the automated tools also

- Ranked proposals in each category

- Reported scores, ranking, standard deviation, and proposed cost as well as proposal identification information to Source Evaluation Board.

2.3.3. Research Initiative Management

The IV&V Facility will manage the execution of research initiatives. The Facility will

- Track research initiative status;

- Review deliverables;

- Conduct formal quarterly reviews of each research initiative;

- Provide technical and program direction;

- Disseminate appropriate research initiative deliverables through the SARP Results website;

- Conduct an annual symposium to disseminate the research initiative results.

2.3.3.1. Track Research Initiative Status

Once funded research on a research initiative officially begins, the IV&V Facility Advanced System and Software Engineering Technologies (ASSET) support contractor will frequently

monitor actual research initiative deliverables and apprise the IV&V Facility Research Lead of late submittals.

The ASSET contractor maintains the CIM Tool. The CIM Tool provides end -to-end research project management support. The CIM Tool is a web -based knowledge management tool. The IV&V Facility Research Lead, the WVU Research Chair, the OSMA SARP Principal Investigators and the ASSET contractor all use the CIM tool. Starting with proposals, the ASSET contractor uploads PI proposals into the CIM tool. Proposal evaluators use the CIM tool to evaluate proposals. Once NASA awards center initiatives, grants or contracts, PIs up load their deliverables into the CIM Tool. The ASSET contractor, the IV&V Facility Research Lead and the IV&V Facility Research Chair use the CIM Tool to conduct research initiative reviews.

Attachment C, FY04 Proposal Delivery Schedule, identifies FY04 scheduled deliverables.

2.3.3.2. Review Deliverables

The ASSET support contractor will perform a cursory review of each research initiative deliverable to determine if the deliverable conforms to the research initiative proposal. The ASSET support contractor will recommend acceptance, rejection, or formal evaluation. The NASA IV&V Facility Research Lead or a delegated civil servant will review the deliverable and decide whether to accept it, reject it or have a formal evaluation performed. If the NASA IV&V Facility Research Lead decides to have a formal evaluation performed, he will select appropriate subject matter expert(s) to perform the evaluation. Contractor and government deliverable review evaluation results and decisions will all be documented in the CIM Tool.

2.3.3.3. Quarterly Reviews

The IV&V Facility Research Lead will hold quarterly teleconferences with the principle investigator for each research initiative. The Research Lead and subject matter experts will also review research initiative progress, activities, accomplishments and deliverables on a quarterly basis. The Research Lead may conduct "site visits" which include, but are not limited to, attending status briefings, demonstrations and product reviews, enhancing customer relations, and ensuring program penetration.

2.3.3.4. Technical and Program Direction

The IV&V Facility Research Lead will provide technical and program direction to research initiative principal investigators as a result of informal and formal research initiative reviews and program developments.

2.3.3.5. Results Website

Appropriate research initiative deliverables are disseminated through the IV&V Facility OSMA SARP Results website. All research initiative deliverables are stored in the NASA CIM Tool. Research initiative deliverables include executable software as well as research papers and progress reports. In FY04, the IV&V Facility activated a OSMA SARP Results Web Site http://sarpresults.ivv.nasa.gov/sarpdir/Index The website makes available research initiative deliverables that are worth disseminating and that have been authorized by NASA for access. One purpose of the SARP Results Web Site is to help software development projects select the optimal information and tools for their application and environment.

2.3.3.6. Symposium

The IV&V Facility organizes an annual NASA OSMA Software Assurance Symposium (SAS). The SAS is the formal report of the program status to the sponsoring organization, Code Q. The SAS brings together practitioners and theorists in the field of software assurance research. This conference facilitates researcher's interactions and the communication of their results. Those in attendance include but are not limited to the research initiative principal investigators, other researchers and individuals involved in the OSMA SARP. SAS 04 will be scheduled for May 2004.

2.4. Theoretical and Applied Research - West Virginia University Initiatives

The WVU software assurance research program will be linked to the software assurance research currently being done and proposed within the NASA Centers. In order to effectively manage the software assurance research being done at WVU under the cooperative agreement, the IV&V Facility will accept proposals from WVU in the form of University Software Initiative Proposals (USIPs), similar to the concept of a NASA CSIP. While the intended focus of the CSIP research is *applied* , the focus of the WVU USIP research can be either applied or *theoretical*. In either case, USIP research is expected to complement the CSIP research. The IV&V Facility shall select the USIPs to be funded with approval of the OSMA Software Assurance Manager.

WVU USIPs are due by September 2003.

2.5. Technical Analyses

The IV&V Facility in collaboration with WVU performs technical and systems engineering assessments of the research initiatives for the OSMA SARP. This is done to ensure that the research being funded is of the best quality. Assessments are made primarily of the research deliverables, the products of the research. In addition to WVU, the IV&V Facility will use

the expertise of the ASSET contractors to facilitate the technical analyses required to evaluate the research. The roles and responsibilities are described in the following section.

3.0 ROLES AND RESPONSIBILITIES

This section defines the roles and responsibilities of Code Q and the IV&V Facility, its contracting support for technical and systems engineering assessments, the cooperating researchers of West Virginia University and the NASA Centers.

3.1. Deputy Administrator for OSMA

The Deputy Administrator for OSMA acts as final authority for the selection, and, if necessary, the termination of research initiatives.

3.2. OSMA Software Assurance Manager

The OSMA Software Assurance Manager is responsible for oversight of the OSMA SARP, which includes, but is not limited to resolving SARP related issues requiring headquarters level intervention, working with other research efforts across NASA to coordinate and leverage the OSMA SARP direction and its results, help promote research proposals for, and the results of the SARP to, the NASA community, and work with the Chief Engineer's office to help determine the current and future needs of NASA software assurance and engineering across the Agency to better focus the research topics.

3.3. The IV&V Facility

The IV&V Facility is responsible for the management of the SARP. Duties include:

a)   Ensure that each research initiative adheres to OSMA's goals and objectives of providing advanced software assurance methods and techniques for all of NASA's software approaches and technologies;

b)   Evaluate the technical sufficiency of each research initiative in meeting current and future NASA software assurance, development, and management needs (Reference: OSMA Software Assurance Program Level 1 Technical Program Plan for FY04 - FY05);

c)   Ensure technical management and financial review of research initiative deliverables and progress;

d)   Disseminate information relating to research initiative activities, accomplishments and products to NASA Centers via web-based technologies;

e)   Final approval of research deliverables;

f)   Approval of changes in research deliverable schedules and funding levels as well as minor changes in scope;

g)   Oversight of WVU and contractor activities;

h)   Resolution of contractual issues;

i)   Conduct research Quarterly Reviews;

j)   Manage the Software Assurance Symposium;

k)   Monitor the SARP budget.

3.4. WVU Research Chair

WVU shall assign a Research Chair to support collaboration with the IV&V Facility. The Research Chair shall:

a)   Work with IV&V personnel and NASA personnel to identify critical areas in which software assurance research is needed. Provide the SARP with a list of recommended research topics and a description of the recommended research for each topic. Provide the SARP with proposals for those research topics that WVU will pursue.

b)   Track progress of each research initiative and WVU software assurance research efforts.

c)   Facilitate communication between NASA projects and SARP principal investigators from the centers and from WVU ensuring that software assurance research is applicable to NASA projects and that project data are available to support software assurance research.

d)   Ensure the quality of WVU software assurance research and the transition of WVU software assurance research results into NASA projects as appropriate.

e)   Obtain final government approval from the IV&V Facility Research Lead in coordination with the OSMA Software Assurance Manager in all recommendations.

f)   Be an active teaching professor on the WVU faculty so as to maintain contact with the WVU and students.

g)   Serve as the conduit between the SARP and WVU including both professor and student researchers.

3.5. ASSET Support Contract

The purpose of the ASSET contract is to ensure the viability and effectiveness of the research being done through the IV&V Facility as part of the OSMA SARP. The ASSET contractor:

a) Maintains a data repository, known as the CIM tool, to track the status of research initiative deliverables and products, milestones, research focus, and relevant Center and funding information. The ASSET contractor:

  - Ensures the accuracy of data contained in the CIM tool

  - Updates the data contents of the CIM tool

  - Maintains and updates associated support documentation of the CIM tool

  - Allows external internet access to select research deliverables

  - Support WVU and Government review of research status and deliverables

b) Implements, updates and maintains the research initiative evaluation tracking database, which is part of the web-based CIM tool, which tracks for each proposal: the receipt date, point of contact data, reviewers and reviewer scores. The ASSET contractor also performs a statistical analysis on evaluation scores to support selection of research projects from the proposals. The web-based CIM tool facilitates the evaluation process by allowing evaluators to access the proposals and perform the evaluations on -line. The statistical reports for the evaluations of the proposals are updated in real-time as the evaluations are performed.

c) Using the CIM Tool, tracks the progress of each research effort against the proposed schedule, budget, and objectives.

d) Performs a cursory evaluation of each deliverable to determine if it tracks with the researcher's proposal.

e) Provides subject matter experts as requested by the IV&V Facility Research Lead to review deliverables when no in-house government or WVU expertise is available.

f) Provides support for organized visits of representatives primarily from industry and universities via a Visiting Scientist Program, to support work under this contract for varying periods ranging from one day to several months. The purpose of the Visiting Scientist Program is to promote technical interchange with academia, other government laboratories and the U.S. aerospace industry. The Visiting Scientist Program will enhance the government's understanding of system and software engineering technologies for software assurance and will provide a mechanism for technology transfer of industry and academia expertise to the NASA business enterprises and vice versa.

g) Organizes and runs the annual Software Assurance Symposium

h) Participates in developing, updating and technically editing the following items:

Table 3-1: ASSET Supported Items

Item	Description	Frequency
OSMA Level I Technical Program Plan	Describes the OSMA SARP needs for the next three fiscal years	Once a year
OSMA Level II Plan - Annual Operating Plan	Describes software assurance research to advance the state-of-the-art of softw are engineering research for practical application within NASA field programs that ultimately improve software safety, quality, and reliability	Once a year
Facility Research Initiative Web Site Contents	SARP related information posted to web pages on the IV&V Facility web site	Update at least monthly
SARP Results Web Site http://sarpresults.ivv.nasa.gov	Publishes research results	As results become available and are authorized for publication
IV&V Facility ISO Web Stie http://iso9000.ivv.nasa.gov/	IV&V Facility System Level Procedures and Work Instructions	As procedures and work instructions change.

3.6. Researchers

Researchers in the OSMA SARP include both NASA civil servants and private sector individuals. This document distinguishes between civil servants and private sector researchers employed by universities or industry. All researchers are responsible for submitting their deliverables according to the schedule in this plan. NASA Center researchers are also responsible for ensuring that their deliverables have been approved for public release when applicable. Private sector individuals are responsible for ensuring that they comply with the terms and conditions of their grant or contract, especially as it pertains to export control. All researchers are also expected to present their findings in an OSMA Software Assurance Symposium to be scheduled annually as described above.

4.0   REQUEST FOR FUNDING

This section provides a summary of the funding recommendations and then provides detailed breakdowns of funding for renewed initiatives and funding for new initiatives. Finally, this section identifies proposals that the SEB recommends for award should additional funds be available.

4.1. Funding Request Summary

Table 4-1: FY04 Summary of Requested Funding provides a summary of requested FY04 funding. The table includes the requested funding for research (by Center); the recommended funding of university initiative research to be coordinated with West Virginia University; the IV&V Facility contracting support for technical analyses and systems engineering assessments for the OSMA Software Assurance Program (ASSET), IV&V Operating and Maintenance cost, and the Software Productivity Consortium annual dues.

Table 4-1: FY04 Summary of Requested Funding

	FY04 Cost
Center Initiatives	**$3,433,476**
Ames Research Center	$736,625
Glenn Research Center	$275,000
Goddard Space Flight Center	$345,000
Jet Propulsion Laboratory	$855,000
Johnson Space Center	$124,440
NASA Headquarters	$172,960
IV&V Facility	$668,100
Code Q	$256,351
University Initiatives	**$550,000**
WVU/IV&V (Task ID # 400)	$550,000
Contracted Technical Support for OSMA SARP	**$365,000**
ASSET contract (Task ID # 402)	$365,000
IV&V Facility Support Costs	**$245,524**
Software Productivity Consortium	**$6,000**
Total:	**$4,600,000**

> **Comment:** Remove. J. D. Lloyd, 9/22/03

> **Comment:** $4,354,476.new total authorization.

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4.2. Renewed Initiatives

Table 4-2 lists the renewed initiatives and the SARP management team's FY04 incremental funding recommendations for them. The first column of Table 4-2 lists the NASA facility that will manage the initiative. The second column lists the name of the organization that will perform the research. The third column lists the OSMA Task Identification Number for the renewed initiative. The fourth column lists the initiative title and the last column lists the funding that the SEB recommends be applied to the initiative. Note: that is some cases FY03 funds were received late and contracts could not be started on time resulting in a large carryover into FY04. In these cases, the FY04 funds have already been reduced to account for the FY03 carryover.

Table 4-2 Renewed Initiative FY04 Incremental Funding Recommendations

NASA Center	PI Organization	OSMA Task ID #	Title	Recommended FY04 Funding
ARC	QSS Group Inc.	573	Transitioning from Software Requirements Models to Design Models	192,000
GRC	SAIC	444	Software Safety Assurance of Programmable Logic	95,000
GRC	SAIC	443	Analysis & Test of Real-Time Linux Operation Systems	75,000
GRC	SAIC	442	Software Assurance of Web Based Applications	15,000
GSFC	GSFC/SATC	407	System and Software Reliability	120,000
IV&V Facility	Portland State University	580	Optimizing IV&V Benefits Using Simulation	160,000
Code Q	Valimetrics, LLC	572	Runtime Continuous Verification of an Onboard Planner	119,000
IV&V Facility	Titan Systems Corp.	579	IV&V Techniques for Object Oriented Software Systems	143,000
Code Q	University of Alabama	582	Semantic Metrics for Object-Oriented Design	117,351
Code Q	Mountain State Information Systems	578	Completing the Loop: Linking Software Features to Failures	20,000
JPL	JPL	53	Reducing Software Security Risk Through An Integrated Approach	200,000
JPL	JPL	586	Requirements Decomposition Analysis	120,000
			Total:	**1,376,351**

4.3. New Initiatives

Table 4-3 identifies the FY04 new proposals recommended for funding.

The first column of Table 4-3 contains the proposal number. The second column contains the name of the NASA Center that will manage the research initiative. The third column contains the name of the organization that will perform the research. The fourth column contains the title of the proposal. The fifth column lists the funding recommended by the SEB.

Table 4-3: FY04 New Proposals Recommended for Funding

Proposal #	NASA Center	PI Organization	Title	Recommended FY04 Funds
77	JSC	Triakis Corporation	Empirical Assurance of Embedded Software Using Realistic Simulated Failure Modes	124,440
34	JPL	Jet Propulsion Laboratory (JPL)	Contingency Software in Autonomous Systems	260,000
33	JPL	Jet Propulsion Laboratory (JPL)	Model Checking of Artificial Intelligence based Planners	275,000
61	IV&V Facility	SAIC	Practical Model Checking to Enforce Domain-Specific Interfaces and Requirements	126,100
76	IV&V Facility	Titan Systems Corporation	Tandem Experiments in Finding Faults During Model-Based Development	239,000
49	HQ	Center for Reliability Engineering, UMD	Integrating Software Into Probabilistic Risk Assessment	172,960
22	GSFC	SAIC	Formal Approaches to Swarm Technologies	225,000
88	GRC	SAIC	Injecting Faults for Software Error Evaluation of Flight Software	90,000
53	ARC	USRA/RIACS	Bayesian Verification & Validation tools for adaptive systems	154,000
67	ARC	NASA Ames Research Center	Program Model Checking Case Studies and Practitioner's Guide	225,000
6	ARC	Ames Research Center (ARC)	Software Engineering Research / Developer Collaborations	165,625
			Total:	2,057,125

4.4. Unfunded Recommended Initiatives

The SEB recommends for award 17 of the 88 received proposals. Section 4.3 New Initiatives above lists the 11 top rated proposals that can be funded within current budget constraints. Table 4-4 below lists those 6 additional proposals that the SEB recommends supporting should additional funds become available.
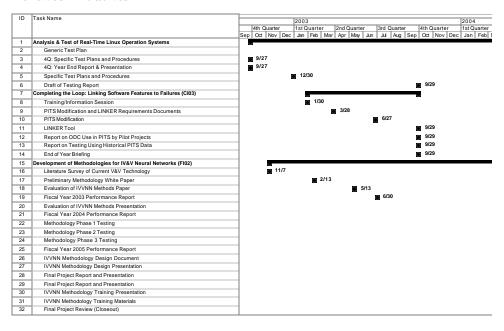
Table 4-4 Prioritized Unfunded Recommended Proposals

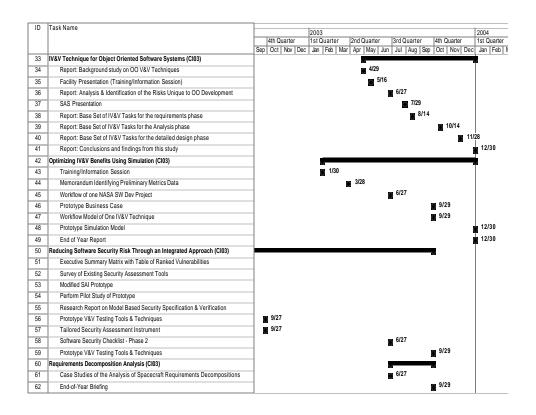| Proposal #	NASA Center	PI Organization	Title	Proposed 2004 Cost
51	Code Q	Arizona State University	Timing and Race Condition Verification of Real-time Systems	129,000
39	TBD	ATC-NY	Mathematical verification of programmable logic	131,794
21	GSFC	Fraunhofer Center Maryland	A Full Lifecycle Approach to Software Defect Management	160,000
5	Code Q	West Virginia Institute of Technology	Programmable Logic Controllers IV&V	124,440
70	MSFC	University of Alabama	Interactive Software Process	91,000
78	JSC	Titan Corporation	Command and Data Exchange Validation Tools for Distributed Software Systems	160,000
			Total:	**796,234**

ATTACHMENTS

ATTACHMENT A. FY04 CENTER PROPOSALS DELIVERABLE SCHEDULE

Table A-1: FY04 Center Proposals Deliverable Schedule

Renewed Initiatives

ID	Task Name	2003 4th Qtr Sep–Dec	2003 1st Qtr Jan–Mar	2nd Qtr Apr–Jun	3rd Qtr Jul–Sep	4th Qtr Oct–Dec	2004 1st Qtr Jan–Feb
1	**Analysis & Test of Real-Time Linux Operation Systems**						
2	Generic Test Plan						
3	4Q: Specific Test Plans and Procedures	9/27					
4	4Q: Year End Report & Presentation	9/27					
5	Specific Test Plans and Procedures		12/30				
6	Draft of Testing Report				9/29		
7	**Completing the Loop: Linking Software Features to Failures (CI03)**						
8	Training/Information Session		1/30				
9	PITS Modification and LINKER Requirements Documents			3/28			
10	PITS Modification			6/27			
11	LINKER Tool				9/29		
12	Report on ODC Use in PITS by Pilot Projects				9/29		
13	Report on Testing Using Historical PITS Data				9/29		
14	End of Year Briefing				9/29		
15	**Development of Methodologies for IV&V Neural Networks (FI02)**						
16	Literature Survey of Current V&V Technology	11/7					
17	Preliminary Methodology White Paper		2/13				
18	Evaluation of IVVNN Methods Paper			5/13			
19	Fiscal Year 2003 Performance Report			6/30			
20	Evaluation of IVVNN Methods Presentation						
21	Fiscal Year 2004 Performance Report						
22	Methodology Phase 1 Testing						
23	Methodology Phase 2 Testing						
24	Methodology Phase 3 Testing						
25	Fiscal Year 2005 Performance Report						
26	IVVNN Methodology Design Document						
27	IVVNN Methodology Design Presentation						
28	Final Project Report and Presentation						
29	Final Project Report and Presentation						
30	IVVNN Methodology Training Presentation						
31	IVVNN Methodology Training Materials						
32	Final Project Review (Closeout)						

Attachments -vi

ID	Task Name	Schedule
33	**IV&V Technique for Object Oriented Software Systems (CI03)**	
34	Report: Background study on OO V&V Techniques	4/29
35	Facility Presentation (Training/Information Session)	5/16
36	Report: Analysis & Identification of the Risks Unique to OO Development	6/27
37	SAS Presentation	7/29
38	Report: Base Set of IV&V Tasks for the requirements phase	8/14
39	Report: Base Set of IV&V Tasks for the Analysis phase	10/14
40	Report: Base Set of IV&V Tasks for the detailed design phase	11/28
41	Report: Conclusions and findings from this study	12/30
42	**Optimizing IV&V Benefits Using Simulation (CI03)**	
43	Training/Information Session	1/30
44	Memorandum Identifying Preliminary Metrics Data	3/28
45	Workflow of one NASA SW Dev Project	6/27
46	Prototype Business Case	9/29
47	Workflow Model of One IV&V Technique	9/29
48	Prototype Simulation Model	12/30
49	End of Year Report	12/30
50	**Reducing Software Security Risk Through an Integrated Approach (CI03)**	
51	Executive Summary Matrix with Table of Ranked Vulnerabilities	
52	Survey of Existing Security Assessment Tools	
53	Modified SAI Prototype	
54	Perform Pilot Study of Prototype	
55	Research Report on Model Based Security Specification & Verification	
56	Prototype V&V Testing Tools & Techniques	9/27
57	Tailored Security Assessment Instrument	9/27
58	Software Security Checklist - Phase 2	6/27
59	Prototype V&V Testing Tools & Techniques	9/29
60	**Requirements Decomposition Analysis (CI03)**	
61	Case Studies of the Analysis of Spacecraft Requirements Decompositions	6/27
62	End-of-Year Briefing	9/29

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ID	Task Name	Timeline
63	**Runtime Continuous Verification of an Onboard Planner (CI03)**	
64	CTL/LTL Specifications for Runtime Plan Verification	12/30
65	Training/Information Session	1/30
66	Java Runtime Engine	3/28
67	Integration	6/27
68	UML Development Environment	9/29
69	**Semantic Metrics for Object-Oriented Design (CI03)**	
70	Training/Information Session	1/30
71	Basic SemMet Development	3/28
72	Complexity Metrics Implementation	6/27
73	Complexity Metrics Test & Validation	9/29
74	Basic SemMet Development	12/30
75	Basic SemMet Development Complete	12/30
76	CDQ/O Metrics Test & Validation	12/30
77	**Software Assurance of Web Based Applications (CI03)**	
78	Research Plan	
79	Web Site	
80	Survey Results	
81	Best Practices	9/27
82	Year End Report & Presentation	9/27
83	Best Practices	6/27
84	Guidebook	9/29
85	Pilot Study Report	9/29
86	Training Presentation and Materials	9/29
87	Year End Report and Presentation	9/29

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ID	Task Name	2003 4th Quarter				1st Quarter			2nd Quarter			3rd Quarter			4th Quarter			2004 1st Quarter		
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	M
88	**Software Safety Assurance of Programmable Logic (CI03)**																			
89	Survey Formats																			
90	Survey Results																			
91	Survey Analysis	9/27																		
92	Year End Report & Presentation	9/27																		
93	Gap Analysis							3/28												
94	OSMA Presentation													9/29						
95	**System and Software Reliability (CI03)**																			
96	Research and Identify New Software Models							3/28												
97	Incorporate New Software Models into SMERFS^3													9/29						
98	**Transitioning from Software Requirements Models to Design Models (CI03)**																			
99	Report on Methodology of Applying Refinement Patterns										6/27									
100	First Version of Catalogue of Refinement Patterns													9/29						

Attachments -ix

New Initiatives

ID	Task Name	Jun	3rd Quarter Jul Aug Sep	4th Quarter Oct Nov Dec	2005 1st Qua Jan F
1	**Bayesian Verification & Validation tools for adaptive systems**				
2	Report on principle of operation and prototypical implementation of Bayesian Envelope tool for Neural Networks		■ 9/30		
3	Prototypical implementation of Bayesian Performance Modeling tool for system identification and report on initial experiments				
4	Report on approach to extend tools toward other model representation methods				
5	Report on Case Study I				
6	Report on Case Study II				
7	Report on Case Study III				
8	Final Report on Feedback of Case studies, tool maturation and technology infusion plan				
9	**Contingency Software in Autonomous Systems**				
10	Set of Autonomous Rotorcraft (ARP) contingencies (ARC) to meet objective #1	■ 6/30			
11	End-of-year briefing (ARC/JPL)		■ 9/30		
12	Tool-based verification of ARP contingency scripts to meet objective #2				■ 12/31
13	Selected set of Mars Science Lab (MSL) contingencies (JPL) to meet objective #3				
14	End-of-year briefing (ARC/JPL)				
15	Tool-based verification of Mars Science Lab contingency software (JPL) to meet objective #4				
16	Safe-release (pilot to autonomous flight) ARP contingencies to meet objective #5				
17	End-of-year briefing (ARC/JPL)				
18	Demonstration for ARP (ARC) and MSL (JPL) to meet objective #6				
19	Final report (ARC/JPL)				
20	**Empirical Assurance of Embedded Software in its Virtual Target Environment Using Realistic Simulated Failure Modes**				
21	SAS 04 Project Presentation		■ 9/30		
22	End-of-year project briefing		■ 9/30		
23	Phase I Summary Report				
24	Mini-AERCam simulator & documentation				
25	SAS 05 Project Presentation				
26	End-of-year project briefing				
27	SAS 06 Project Presentation				
28	Phase II Summary Report				
29	OSP simulator & documentation				
30	**Formal Approaches to Swarm Technologies**				
31	Properties needed for swarm formal method				
32	Model and outline for swarm-based formal method	■ 6/30			
33	End of year briefing		■ 9/30		
34	Final formal method for swarms				■ 12/31
35	Formal specification of ANTS mission using new formal method.				
36	Requirements and Design for tools for supporting formal method				
37	Prototype formal method support tools				
38	End of year briefing				

Attachments - x

ID	Task Name		3rd Quarter		4th Quarter		2005 1st Qua	
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	F
39	**Injecting Faults for Software Error Evaluation of Flight Software**						
40	FCF CSCI and Interface Criticality Analysis						
41	FCF Software Fault Injection Test Plan	6/30					
42	Paper on what was learned in applying software fault injection for this project.						12/31
43	**Integrating Software Into Probabilistic Risk Assessment**						
44	Final Report						
45	End of Year Briefing						
46	Report describing the results of the scalability study for the Test-Based Approach	6/30					
47	Report describing the analytical propagation approach				9/30		
48	End of Year Briefing				9/30		
49	Report describing the application of the analytical propagation approach to a large scale system						
50	Report describing the algorithms to partially automate the test-based approach and analytical approach.						
51	Final Report: Report describing the PRA procedure (Test-Based and Analytical)						
52	End of Year Briefing						
53	**Model Checking of Artificial Intelligence based Planners**						
54	Identification of requirements on the AI engine						
55	Classification of requirements (temporal vs. non temporal)						
56	Initial Spin model of AI engine	6/30					
57	Initial Spin model of the environment				9/30		
58	End of year briefing (initial evaluation of lessons learned, technical hurdles overcome, identification of new tools and tool extensions)				9/30		
59	Specifications for tool extensions and/or new tools						12/31
60	Library of reusable, formalized temporal requirements						
61	Initial version of tool extensions and/or new tools						
62	Final Spin model of AI engine and environment, model checking results reported to development team						
63	End of year briefing (evaluation of applicability of model checking to AI based planners by team and development organization)						
64	Report of model checking results (faults found, metrics on effectiveness), and formal feedback to development team.						
65	Final version of tool extensions and/or new tools						
66	Tool and method user documentation						
67	Guidelines for applying model checking to AI based planners, and a repository of correctness properties for JPL and other NASA center u						
68	End of year briefing (includes prospects for leveraging this work on NASA projects, identification of likely NASA projects for application)						
69	Final Report						

Attachments -xi

ID	Task Name		3rd Quarter			4th Quarter			2005 1st Quarter	
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	F
70	**Practical Model Checking to Enforce Domain-Specific Interfaces and Requirements**									
71	Identify NASA projects and specific "challenge problem" queries for implementation.									
72	Report on first year's findings.				■ 9/30					
73	List of queries to be implemented in year 2.							■ 12/31		
74	Report on second year's findings.									
75	Detailed plan to transition the automated approach to the IV&V Facility									
76	Status report on transition activities.									
77	Training for IV&V center practitioners.									
78	Final report.									
79	**Program Model Checking Case Studies and Practitioner's Guide**									
80	Current metrics for the selected application	■ 6/30								
81	End of year briefing				■ 9/30					
82	Verification goals				■ 9/30					
83	Modified application to improve verifiability									
84	End of year briefing									
85	Metrics for redesigned application									
86	Draft Practitioner's Guidebook									
87	End of year briefing									
88	Practitioner's Guidebook (final)									
89	**Software Engineering Research / Developer Collaborations**									
90	Report on the planned collaborations	■ 6/30								
91	Final Report on Collaboration no. 1							■ 12/31		
92	Final Report on Collaboration no. 2							■ 12/31		
93	Lessons learned on technology transfer report							■ 12/31		
94	End-of-year briefing							■ 12/31		

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ID	Task Name														
										2005					
			3rd Quarter			4th Quarter			1st Qua						
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	F					
95	**Tandem Experiments in Finding Faults During Model-Based Development**														
96	SAS report	■ 6/30													
97	SAS report														
98	SAS report														
99	Report, review, utility MAAB for NASA models														
100	Report, use, MAAB, on MATLAB model1	■ 6/30													
101	Report, use, MAAB, on MATLAB model2				■ 9/30										
102	Report, use, MAAB, on MATLAB model3							■ 12/31							
103	Report, interface, LURCH to RC Models							■ 12/31							
104	Report (initial), interface, LURCH, MATLAB models							■ 12/31							
105	Report (final), interface, LURCH, MATLAB models														
106	Report, results, SPIN/SMV on RC1														
107	Report, results, LURCH on RC1														
108	Report, results, LURCH on RC2														
109	Report (final), interface, LURCH, MATLAB models														
110	Report, results, LURCH on MATLAB model1														
111	Report, results, LURCH on MATLAB model2														
112	Report, results, LURCH on MATLAB model3														
113	Final Report														

Delivery schedule assumes funds are received by 15 November 2003 and new grants and contracts are in plac

Attachments-xiii

ATTACHMENT B.   ACRONYMS

Table B-1: Acronym List

Acronym	Expansion / Definition
ASSET	Advanced Systems and Software Engineering Technologies
CI	Center Initiative
CIM	Center Initiative Management (tool)
CSIP	Center Software Initiative Proposal (CI proposal)
DPM	Delegated Program Manager
GRC	Glenn Research Center
GSFC	Goddard Space Flight Center
ISO	International Organization for Standardization
IV&V	Independent Verification and Validation
NRA	NASA Research Announcement
OSMA	Office of Safety and Mission Assurance
POP	Program Operating Plan
PV	Process Verification
SWG	Software Working Group
S&MA	Safety and Mission Assurance
UI	University Initiative
URL	Uniform Resource Locator
USIP	University Software Initiative Proposal
WVU	West Virginia University